dispersed in water than fresh oil, implying that much greater loss of eggs and other susceptible life stages of fishes and invertebrates is routinely happening from even small oil spills and repeated exposures in stormwater than had been assumed before

E. Implications for oil-and-gas development in North Carolina
    a. Including small spills, the EPA reports that an oil spill occurs in the U.S. at a rate of 70 times per day
    b. Most of these spills occur during transport of the oil, although the largest are associated with accidents like storms or collisions or explosions
    c. Double-tanking of oil tankers promised as a precautionary remedy after the Exxon Valdez spill is incomplete
    d. The analogous shoreline environments at risk to long-term contamination leading to fish and wildlife mortality in NC are estuarine salt marshes, oyster reefs, and seagrass beds because oil floats, then penetrates into sediments when stranded during low tide, where it can become protected from oxygenation and weathering
        i. The salt marsh is the environment of greatest concern because it is (1) entirely intertidal in elevation where oil will come readily to reside, (2) physically quiescent such that sediments are unoxygenated and thus ideal reservoirs for persistent oil contamination, and (3) the coastal habitat of greatest significance of all for fish and wildlife production, water quality maintenance, shoreline stabilization, and other ecosystem services
        ii. Impacts of oil on salt marshes persist for decades to centuries, as discussed in the classic review by Teal & Howarth (1984):

Teal, J., and R. Howarth. 1984. Oil spill studies: a review of ecological effects. Environmental Management 8: 27-44.

        iii. Follow-up study of Cape Cod salt marshes oiled 40 years ago by a spill from the barge *Florida* demonstrated that a layer of toxic PAHs was still evident at soil depths of 1-20 cm, the most important animal of the marsh, fiddler crabs, which dig burrows into the soils and process organic matter and energy, were still depressed in abundance, dug burrows only half as deep as normal, and exhibited abnormal sluggish behavior. The marsh plants themselves were also still dwarfed in size.

        iv. Estuarine oyster reefs, which are also at intertidal elevations south of Cedar Island and thus experience coating by oil as the tide recedes, are now targets of active restoration in recognition of their ecosystem services to water quality, fish habitat, as a fishery themselves, and as shoreline stabilizers. They stand at risk from development of local oil development.

        v. Seagrass beds (SAV) represents a vital nursery habitat for shrimp, bay scallops, and numerous fishes, one that has already suffered great decline and is aggressively protected from further injury and loss in coastal management programs. This shallow habitat is also at risk from spilled oil and studies show multi-year losses of natural function of SAV after oil spills.